AQUATIC INVERTEBRATES AND HABITAT OF CUT BANK CREEK AND OLD MAIDS COULEE: GLACIER COUNTY, MONTANA
Project TMDL-M16

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A report to

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by

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INTRODUCTION

Benthic assemblages are aptly applied to aquatic bioassessment since they are known to be important indicators of stream ecosystem health (Hynes 1970). Long lives, complex life cycles and limited mobility mean that there is ample time for the benthic community to respond to cumulative effects of environmental perturbations.

Multimetric approaches to bioassessment use attributes of the assemblage in an integrated way to measure biotic integrity, defined by Karr and Dudley (1981) as "...the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitats within a region." The additive multimetric approach designed by Plafkin et al. (1989) and adapted for use in the State of Montana has been defined as "... an array of measures or metrics that individually provide information on diverse biological attributes, and when integrated, provide an overall indication of biological condition." (Barbour et al. 1995). Community attributes that can contribute meaningfully to interpretation of benthic data include assemblage structure, sensitivity of community members to stress or pollution, and functional traits. Each metric component contributes an independent measure of the biotic integrity of a stream site; combining the components into a total score reduces variance and increases precision of the assessment (Fore et al. 1996). Effectiveness of the integrated metrics depends on the applicability of the underlying model, which rests on a foundation of three essential elements (Bollman 1998a). The first element is an appropriate stratification or classification of stream sites, typically, by ecoregion. Second, metrics must be selected based upon their ability to accurately express biological condition. Third, an adequate assessment of habitat conditions at each site to be studied must be done, to assist in the interpretation of metric outcomes.

This report summarizes data collected on August 29-30, 2002 from Cut Bank Creek and its tributary, Old Maids Coulee, located in Glacier County, Montana, by means of a multimetric method, an adaptation of the U.S. EPA's Rapid Bioassessment Protocols (RBP III) (Plafkin et al. 1989). Macroinvertebrates were collected at four sites, all of which are located in the Plains ecoregion (Woods et al. 1999). The purpose of the study is to provide information that may be pertinent to the development of pollution control plans or Total Maximal Daily Loads as mandated by the Clean Water Act.

Metric selection for this study is based on the recommendations found in the standard operating procedures for macroinvertebrate sampling and analysis of the Montana Department of Environmental Quality (Montana DEQ) (Bukantis 1998). Implicit in the multimetric method and its associated habitat assessment is an assumption of correlative relationships between habitat parameters and the biotic metrics, in the absence of water quality impairment. These relationships may vary regionally, requiring an examination of habitat assessment elements and biotic metrics and a test of the presumed relationship between them. Assurance of the validity of association between habitat parameters and biotic metrics is particularly compelling in the Plains ecoregion, since impairment of the biotic health of streams in this region is generally the result of non-point sources. Agricultural activities, including cattle grazing and flow alteration, are predominant causes of stream degradation. The benthic assemblages of the Plains ecoregions and the performance of bioassessment metrics have not yet been examined thoroughly enough to determine whether or not the individual metrics or their integrated scores can discriminate impaired conditions from good biotic health. Thus, conclusions concerning bioassessment based upon these metrics must be regarded as tentative.

Habitat assessment enhances the interpretation of biological data (Barbour and Stribling 1991), because there is generally a direct response of the biological community to habitat degradation in the absence of water quality impairment. If biotic health appears more damaged than the habitat quality would predict, water pollution by quantities of organic materials, nutrients, metals, or other toxicants might be

suspected. On the other hand, an "artificial" elevation of biotic condition in the presence of habitat degradation may be due to the paradoxical effect of mild nutrient or organic enrichment. Habitat assessment data is even more important in the Plains ecoregions, where the relationships between habitat variables and benthic community characteristics remain largely unknown.

METHODS

Aquatic macroinvertebrates were sampled by personnel of the Montana DEQ from three sites on Cut Bank Creek and one site on Old Maids Coulee on August 29-30, 2002. Sampling site designations and locations are listed in Table 1a. The site selection and sampling method employed were those recommended in the Montana Department of Environmental Quality (DEQ) Standard Operating Procedures for Aquatic Macroinvertebrate Sampling (Bukantis 1998). The Kick collection procedure was employed for Sites 1,2, and 4, and the Jab for Site 3; duration and length are indicated in Table 1b.

Table 1. Sample designations and locations. Cut Bank Creek and Old Maids Coulee. August 29-30, 2002. Sites are listed in upstream-to-downstream order.

Site	Station ID	Activity ID	Location description	Latitude/Longitude
1	M16CBNKC02	02-L415-M	Cutbank Creek near USGS gauge	48°37'58"/112°20'47"
2	M16CBNKC03	02-L416-M	Cutbank Creek downstream of Tank Hill	48°36'16"/112°20'14"
3	M16CBNKC05	02-L413-M	Cutbank Creek near mouth	48°29'28"/112°13'59"
4	M16OLMDC01	02-L412-M	Old Maids Coulee downstream of hwy	48°38'51"/112°19'32"

Table 1b. Sample collection procedure, duration, and length. Cutbank Creek and Old Maids Coulee. August 29-23, 2002.

Site	Date	Collection Procedure	Duration	Length	# and Depth of Jabs
1	8-30-02	KICK	1 MINUTE	20 FEET	
2	8-30-02	KICK	1 MINUTE	20 FEET	
3	8-29-02	KICK	1 MINUTE	20 FEET	
4	8-29-02	KICK		25 FEET	5-2'

In addition to macroinvertebrate sample collection, habitat quality was visually evaluated at the four sites and reported by means of the habitat assessment protocols recommended by Bukantis (1998). Both riffle/run dominated and glide/pool dominated systems were encountered. Macroinvertebrate samples and associated habitat data were delivered to Rhithron Associates, Inc., Missoula, Montana for laboratory and data analyses.

In the laboratory, the RBP III sorting method was used to obtain subsamples of 300 (+/- 10%) organisms from each sample when possible. Organisms were identified to the lowest practical level. Community structure, function, and sensitivity to impact were characterized for each subsample using a battery of ten attributes, or metrics, recommended by Bukantis (1998) for streams of the Plains ecoregions. Actual metric values from each sample were compared to ecoregional

reference values to obtain scores. The bioassessment metric battery and metric reference values are given in Table 3. Scores for all metrics were combined, and a total bioassessment score was expressed as a percentage of the maximum possible score. Total bioassessment scores were interpreted in terms of aquatic life or other uses according to guidelines established by Montana DEQ (Bukantis 1998) and elaborated in Tables 3a and 3b in this report.

Table 2. Provisional metrics and scoring criteria for the Montana Plains ecoregions. (Bukantis, 1998).

	Score			
Metric	**3**	**2**	**1**	**0**
Taxa richness	>24	24 - 18	18 – 12	<12
EPT richness	>8	8 – 6	5 – 3	<3
Biotic Index	<5	5 – 6	6 – 7	>7
% Dominant taxon	<30	30 – 45	45 – 60	>60
% Collectors	<60	60 – 80	80 – 95	>95
% EPT	>50	50 – 30	30 – 10	<10
Shannon H (log2)	>3.0	3.0 – 2.4	2.4 – 1.8	<1.8
% Scrapers + shredders	>30	30 – 15	15 – 3	<3
# Predator taxa	>5	4 – 5	3 – 4	<3
% Multivoltine	<40	40 - 60	60 – 80	>80

Table 3a. Criteria for the assignment of use-support classifications / standards violation thresholds (Bukantis, 1998).

% Comparability to reference	Use support
>75	Full support--standards not violated
25-75	Partial support--moderate impairment--standards violated
<25	Non-support--severe impairment--standards violated

Table 3b. Criteria for the assignment of impairment classifications (Plafkin et al. 1989).

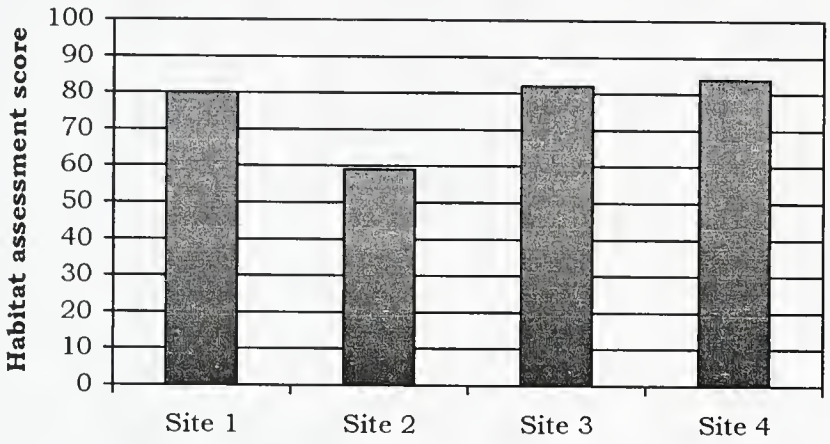
% Comparability to reference	Classification
> 83	nonimpaired
54-79	slightly impaired
21-50	moderately impaired
<17	severely impaired

RESULTS

Habitat Assessment

Figure 1 graphically compares total habitat assessment scores for the four sites. Table 4 shows the habitat parameters evaluated, parameter scores and overall habitat evaluations for the four sites studied.

Figure 1. Total habitat assessment scores for sites on Cut Bank Creek and Old Maids Coulee. August 29-30, 2002.



Overall habitat conditions at the uppermost site (Site 1) scored optimally. Benthic substrate diversity was perceived to be good, with many boulders as well as some submerged trash noted. Sediment deposition as well as channel alteration was judged minimal; streambanks appeared moderately stable. According to field notes, the riparian zone exhibited past disruption.

Sub-optimal habitat conditions were perceived on Cut Bank Creek at Site 2. The diminished score appeared to be chiefly related to unstable streambanks. Field notes report vertical raw banks with disrupted vegetative protection. Riparian zone width was judged to be abbreviated. Substrate diversity was perceived to be sub-optimal, with particle diversity ranging from fines and sand to boulders.

Optimal habitat conditions were reported at Site 3 on Cut Bank Creek. Substrate particle diversity was judged optimal, and sediment deposition was not perceived to be inappropriate for the C-3 stream type encountered here. Streambanks appeared to be moderately stable, and the riparian zone width was not judged to be excessively abbreviated.

At Site 4 on Old Maids Coulee, habitat was judged optimal. Muddy substrates were reported, which were perceived to be entirely appropriate for the glide and pool stream type encountered here. No evidence of channel alteration was found, and streambanks were judged moderately stable. The width of the riparian zone was reported to be near its potential, given the narrow canyon it occupied.

Table 4. Stream and riparian habitat assessment. Sites 1, 2 and 3 were assessed based upon criteria developed by Montana DEQ for streams with riffle/run prevalence, while the assessment for Site 4 was based upon criteria developed for streams with glide/pool prevalence. Cut Bank Creek and Old Maids Coulee. August 29-30, 2002.

Max. possible score	Parameter	Site 1	Site 2	Site 3	Max. possible score	Parameter	Site 4
10	Riffle development	8	5	8	-	Bottom substrate	Not scored
10	Benthic substrate	7	8	9	20	Pool substrate char.	15
20	Embeddedness	17	18	18	20	Pool variability	18
20	Channel alteration	16	12	18	20	Channel alteration	18
20	Sediment deposition	16	14	17	20	Sediment deposition	17
20	Channel flow status	18	16	18	20	Channel sinuosity	15
20	Bank stability	8 / 8	2 / 2	6 / 8	20	Channel flow status	18
20	Bank vegetation	7 / 7	4 / 4	6 / 9	20	Bank vegetation	9 / 9
20	Vegetated zone	8 / 8	5 / 5	6 / 8	20	Bank stability	8 / 8
160	Total	128	95	131	20	Vegetated zone	8 / 8
					180	Total	151
	Percent of maximum	**80%**	**59%**	**82%**		Percent of maximum	**84%**
	CONDITION*	**OPTIMAL**	**SUB-OPTIMAL**	**OPTIMAL**		CONDITION*	**OPTIMAL**

* Condition categories: Optimal > 80% of maximum score; Sub-optimal 75 - 56%; Marginal 49 - 29%; Poor <23%. Adapted from Plafkin et al. 1989.

Bioassessment

Table 5 itemizes each contributing metric and shows individual metric scores for each site. Figure 2 summarizes bioassessment scores for aquatic invertebrate communities sampled at the 4 sites in this study. Tables 3a and 3b above show criteria for impairment classifications (Plafkin et al. 1989) and use-support categories recommended by Montana DEQ (Bukantis 1998). Macroinvertebrate taxa lists, metric results and other information for each sample are given in the Appendix.

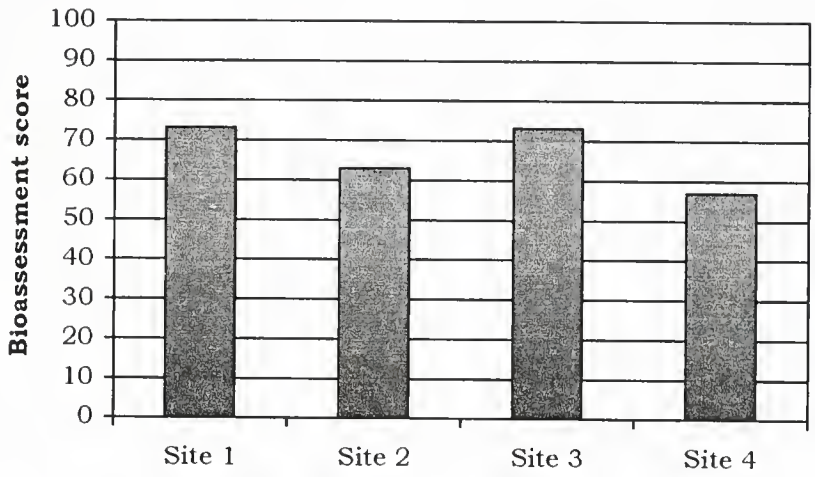
When this bioassessment method is applied to these data, scores indicate slight impairment of biotic health and partial support of designated uses at all sampled sites.

Table 5. Bioassessment metrics and scores for sites on Cut Bank Creek and Old Maids Coulee. August 29-30, 2002. Montana plains ecoregions reference (Bukantis 1998).

VALUES	**Site 1**	**Site 2**	**Site 3**	**Site 4**
Taxa richness	23	19	15	20
EPT richness	10	10	10	3
Biotic Index	5.12	4.65	3.84	6.92
% dominant taxon	20.06	52.43	31.03	30.06
% collectors	83.09	82.20	45.69	75.63
% EPT	62.18	94.17	73.28	2.53
Shannon diversity	2.87	1.78	2.71	3.10
% Scrapers + shredders	15.74	16.83	8.19	18.35
# Predator taxa	4	3	3	3
% Multivoltine	43.77	30.50	16.06	35.44
SCORES				
Taxa richness	2	2	1	2
EPT richness	3	3	3	1
Biotic Index	2	3	3	1
% dominant taxon	3	1	2	2
% collectors	1	1	3	2
% EPT	3	3	3	0
Shannon diversity	2	0	2	3
% Scrapers + shredders	2	2	1	2
# Predator taxa	2	1	1	1
% Multivoltine	2	3	3	3
TOTAL SCORE	22	19	22	17
PERCENT MAXIMUM	**73%**	**63%**	**73%**	**57%**
IMPAIRMENT CLASSIFICATION[1]	**SLI**	**SLI**	**SLI**	**SLI**
USE SUPPORT[1]	**PART**	**PART**	**PART**	**PART**

[1]See Table 3a for impairment classification criteria and Table 3b for use support criteria.

Figure 2. Total bioassessment scores compared among sites on Cut Bank Creek and Old Maids Coulee. August 29-30, 2002. Montana DEQ Plains ecoregions reference criteria were used to determine scores. Scores are reported as the percent of maximum possible score.



Aquatic invertebrate communities

Interpretations of biotic integrity in this report are made without reference to results of habitat assessments, or any other information about the sites or watersheds that may have accompanied the invertebrate samples. Interpretations are based entirely on: the taxonomic and functional composition of the sampled invertebrate assemblages; the sensitivities, tolerances, physiology, and habitus information for individual taxa gleaned from the writer's research; the published literature, and other expert sources; and on the performance of bioassessment metrics, described earlier in the report, which have been demonstrated to be useful tools for interpreting potential implications of benthic invertebrate assemblage composition.

The uppermost site on Cut Bank Creek (Site 1) supported no fewer than 7 mayfly taxa, suggesting that water quality was good in this reach. The biotic index value (5.12) calculated for the assemblage was mildly elevated compared to the ecoregion reference, suggesting that water temperatures may have been relatively warm. Evidence for warm water temperatures was apparent in the taxonomic composition of the benthic assemblage; the mayfly *Stenonema* sp. and the aquatic moth *Petrophila* sp. both prefer warm water. Temperatures were not so warm as to exclude the perlodid stonefly *Isogenoides* sp., however. These animals and the thermal regime they imply seem to be entirely appropriate for a Plains stream.

Ten "clinger" taxa were collected; this finding suggests that hard benthic substrates were not excessively impacted by fine sediment deposition, and were abundantly available for colonization. The burrowing mayfly *Ephemera simulans* was also present at the site, implying that soft sandy substrates were also available, adding to the complexity of available habitats. A complex variety and abundant availability of instream habitats is suggested by high taxa richness (23 taxa). The functional composition of the sampled assemblage was largely made up of gatherers, filterers, and scrapers, with a small contingent of predators. This mix seems appropriate for a large Plains stream.

Good water quality appears to have persisted downstream at Site 2, where the calculated biotic index value (4.65) was within expectations for the ecoregion reference. The mayfly fauna was similar to that of the upstream site; seven taxa were collected. Warm water, characteristic of Plains streams, was suggested by the presence of the snails *Ferrissia* sp. and *Physa* sp., but a moderate thermal regime is implied by the presence of *Isogenoides* sp.

Seventy-two percent of collected organisms were "clingers"; seven taxa were represented. Fine sediment deposition did not prohibit colonization of hard substrates. Soft substrates were also available, since *Ephemera simulans* was also collected. Filterers made up the largest proportion of functional components. The dominant taxon was the net-spinner *Hydropsyche* sp. This suggests that fine organic particulates in suspension were plentiful. Gatherers and scrapers also contributed significantly to the functional mix.

Near its mouth (Site 3), Cut Bank Creek supported fewer taxa than at the upstream or tributary sites, and the abundance of organisms was low. Only 232 animals were collected in the sample. Still, five mayfly taxa were collected, and the biotic index value (3.84) suggested that water quality was unimpaired by nutrients or organic pollution. The assemblage exhibited a mix of warm-to-cool water taxa similar to the upstream sites, but the stonefly *Isogenoides* sp. was particularly abundant here, suggesting that the thermal regime may have been somewhat cooler here than at the other Cut Bank Creek sites. The large population of the perlodid stonefly accounts for the large proportion of predators among the functional components of the invertebrate community. Other significant contributors to the functional mix were filterers, gatherers and scrapers; this seems appropriate for a large Plains stream. Seven "clinger" taxa made up 44% of sampled animals, suggesting that hard substrates unimpaired by fine sediment deposition were available.

The tributary site on Old Maids Coulee (Site 4) yielded an assemblage with a single mayfly taxon, and a biotic index value (6.92) elevated above expectations. Warm water temperatures are suggested by these findings, and it's possible that some nutrient and/or organic loading is indicated as well. Thirty percent of collected organisms were immature tubificid worms, which prefer enriched waters and soft hypoxic substrates.

Consistent with a soft-bottomed environment, "clingers" were represented by only 3 taxa. However, one of these, the midge *Cricotopus* sp., was abundant. This suggests that some hard substrate was available. Macrophytes may have contributed to habitat complexity at this site, since shredders (the midge *Brillia* sp. and the amphipod *Gammarus* sp.) made up a significant proportion of the assemblage. Most of the other organisms present in the sample are classified as gatherers.

CONCLUSIONS

- Water quality unimpaired by excessive nutrient and/or organic pollution appears to characterize the 3 sampled sites on Cut Bank Creek.

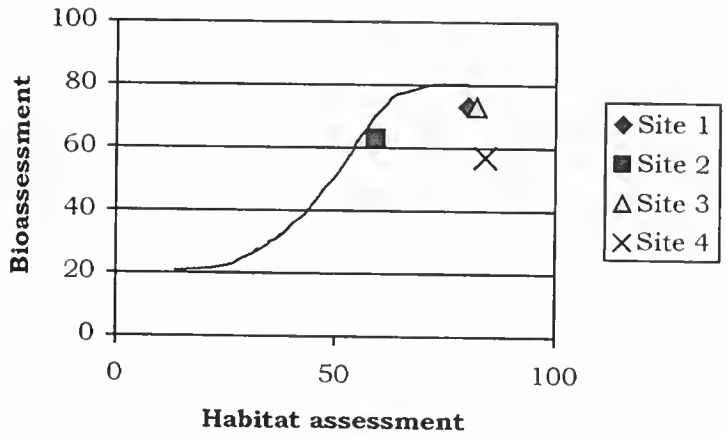
- Habitat indicators suggested that instream habitats were complex, available, and essentially intact at all 3 Cut Bank Creek sites.

- Warm water temperatures and perhaps nutrient enrichment are suggested by the fauna collected at the Old Maids Coulee site. Instream habitat appeared to

be simpler than at Cut Bank Creek sites, but this is consistent with soft substrates.

- The relationship between habitat scores and bioassessment scores is illustrated in Figure 3. The symbol representing Site 3 falls in the portion of the graph suggesting impaired water quality.

Figure 3. Total bioassessment scores (Plains ecoregions reference) plotted against habitat assessment scores for sites on Cut Bank Creek and Old Maids Coulee. August 29-30, 2003. The red line describes the hypothetical relationship expected when water quality is good and biotic health is determined predominantly by habitat quality (Barbour and Stribling 1991).



LITERATURE CITED

Barbour, M.T. and J.B. Stribling. 1991. Use of habitat assessment in evaluating the biological integrity of stream communities. In: *Biological Criteria: Research and Regulation.* Proceedings of a Symposium, 12-13 December 1990, Arlington, Virginia. EPA-440-5-91-005. U.S. Environmental Protection Agency, Washington, DC.

Barbour, M.T., J.B. Stribling and J.R. Karr. 1995. Multimetric approach for establishing biocriteria and measuring biological condition. Pages 63-79 in W.S. Davis and T.P. Simon (editors) *Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making.* Lewis Publishers, Boca Raton.

Bollman, W. 1998a. I*mproving Stream Bioassessment Methods for the Montana Valleys and Foothill Prairies Ecoregion.* MS Thesis. University of Montana. Missoula, Montana.

Bollman, W. 1998b. Unpublished data generated by state-wide sampling and data analysis; 1993-1998

Bukantis, R. 1998. Rapid bioassessment macroinvertebrate protocols: Sampling and sample analysis SOP's. Working draft. Montana Department of Environmental Quality. Planning Prevention and Assistance Division. Helena, Montana.

Fore, L.S., J.R. Karr and R.W. Wisseman. 1996. Assessing invertebrate responses to human activities: evaluating alternative approaches. *Journal of the North American Benthological Society* 15(2): 212-231.

Hynes, H.B.N. 1970. *The Ecology of Running Waters.* The University of Toronto Press. Toronto.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspective on water quality goals. *Environ. Manage.* 5:55-68.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. *Rapid Bioassessment Protocols for Use in Streams and Rivers. Benthic Macroinvertebrates and Fish.* EPA 440-4-89-001. Office of Water Regulations and Standards, U.S. Environmental Protection Agency, Washington, D.C.

Woods, A.J., J.M. Omernik, J. A. Nesser, J. Shelden, and S.H. Azevedo. 1999. *Ecoregions of Montana.* (Color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia. US Geological Survey.